THE GROUPS OF ANGIOSPERMS.[1]

A. ENGLER.

[IN the form of a supplement[2] to Parts II, III, and IV of *Die Natürliche Pflanzenfamilien*, Dr. Engler has presented a comprehensive review of the taxonomic divisions of spermatophytes. In it he has made important alterations in the sequence and structure of the series as arranged and delimited in the original work. In the light of results obtained since the publication of the earlier parts of the *Pflanzenfamilien*, a rearrangement has been made of which the following abstract from the author's "Erlauterungen" serves to give a general idea. Even the more important details have been rigidly omitted, and for a comprehensive grasp of the reasons for the changes the reader must be referred to the "key" which forms the skeleton of the supplement, and to the context.—EDS.]

The sequence of series and families is treated with special reference to the progressive steps which are manifested in floral structure, fruit and seed development, and differentiation of tissue.

Certain difficulties present themselves in the practical carrying out of such a scheme. It often occurs that within one circle of relationship a certain tribe has advanced in some particular direction, remaining latent in other directions, while the reverse may be true of other related tribes. In other cases it is doubtful whether certain lower stages are primitive, or whether they have arisen through reduction.

Eichler has recognized the so-called apetalous families of dicotyledons as haplochlamydeous, or naked-blooming, instead of abortive, and has placed them at the beginning of dicotyledons. To these I have added Piperales, Proteales, Santalales, and Aristolochiales.

[1] Abstract of translation prepared by Dr. Edwin B. Uline.

[2] ENGLER, A.: Übersicht über die Unterabteilungen, Klassen, Reihen, Unterreihen und Familien der Embryophyta siphonogama. Leipzig: Wilhelm Engelmann. 1897.

Before entering upon a discussion of the sequence of series in the monocotyledons and dicotyledons, I wish to speak of the diagnostic importance which is being laid upon the development of the pollen-tube in the ovule, and the structure of the ovule with respect to the development of the integuments. In the first few series of Archichlamydeæ (*i. e.*, the Piperales, Verticillatæ, Fagales, Juglandales, Myricales, Salicales, Urticales, Proteales, Santalales, and Aristolochiales) the pollen-tube and the ovules show relations which never occur elsewhere in angiosperms. As for the chalazogamy of Treub, the investigations of Nawaschin and others have greatly depreciated its importance from the standpoint of classification, and of late more importance has been laid upon the peculiar conditions which occur in the Santalaceæ and Loranthaceæ in the development of ovules and embryo sacs, as set forth by Van Tieghem, who distinguishes a phanerogamous division "Inovulées" to which the Loranthaceæ and Balanophoraceæ belong, and another division "Innucellées," which about corresponds to our Santalaceæ.

For my part, I do not see sufficient importance in either of these sets of characters to justify the establishment of subdivisions of the first rank. Nor in the fact that in the Loranthaceæ the embryo sac is developed within the tissues of the carpel do I discern peculiarities which justify setting these plants apart as opposed to the remaining dicotyledons and monocotyledons. I can only regard them as dicotyledons which, like all other dicotyledons, are opposed in many respects to monocotyledons, but which in the development of the ovules show certain departures of their own. We can no more found a higher systematic division on the more or less complete development of the ovule than on the presence of endosperm and perisperm, or on the more or less advanced development of the embryo of the mother-plant. Indeed, if the gymnosperms stand in close relation to the pteridophytes, since normally developed ovules with nucellus and integument occur in the gymnosperms, it is natural to assume that the peculiar development of ovules in the Santalales is merely a phenomenon of reduction.

But it is a striking fact that these departures occur in several of those families which were formerly known as apetalous. This seems the more reason why all these families should occupy a lower place in the system of dicotyledons. The manner of fertilization and the development of the embryo sac is here not so fixed as in the other dicotyledons. The Proteaceæ, also, which I have placed much lower than Eichler, show a striking departure from other dicotyledons in that the number of cotyledons may reach even eight.

MONOCOTYLEDONS.

Among the nonocotyledons those series in which typical achlamydeous flowers occur represent the earliest stages of development. These are the Pandanales, Helobiæ, and Glumifloræ. Of these the Pandanales are most primitive, because of indefiniteness of floral parts, and the spiral arrangement of stamens. Whether the Helobiæ or the Glumifloræ stand next in order is difficult to decide. Owing to the great instability prevailing in the Helobiæ, I have preferred to let them precede the Glumifloræ, and have left the Gramineæ and Cyperaceæ together in Glumifloræ.

Common to the three series Principes, Synanthes and Spathifloræ is the appearance of a floral envelope, which in some cases is suppressed by the more vigorous development of the spathe.

Several subseries under the Farinosæ must be set apart; notably the Flagellariineæ, which do not affiliate closely with any other family. The subseries Enantioblastæ is characterized by its orthotropous ovules, while the remaining Farinosæ have anatropous ovules.

Most of the Liliifloræ belong to the subseries Liliineæ. I have regarded the Juncaceæ as a separate subseries, Juncineæ, being intermediate in the structure of their albumen between the Farinosæ and the Lilliifloræ. Likewise I have separated the Iridaceæ as subseries Iridineæ, basing it upon the leafy development and division of the style branches, as well as upon the position of the leaves.

I believe it a misconception to regard the Scitamineæ as direct descendants of the Liliaceæ or of the Amaryllidaceæ. Though the Scitamineæ do resemble Dracæna and Cordyline, stronger characters argue against deriving them from the Liliiflorae, viz., the formation of endosperm and perisperm, the smooth exine and thick intine of the pollen grains, the presence of simple and complex starch grains in the albumen.

The Microspermæ comprise the Burmanniaceæ and Orchidaceæ, whose relationship to each other is based solely upon the numerous small ovules and the parietal placentation. The Burmanniaceæ are like the Orchidaceæ in that they attain a degree of zygomorphism which is found in few monocotyledons, and a careful review of characters shows no possible connecting link between Orchidaceæ and the Liliiflorae. The Microspermæ may fall, therefore, into the two subseries, Burmanniineæ and Gynandræ.

DICOTYLEDONS.

The dicotyledons as here presented show many departures from Eichler's system. One of the most essential changes is the breaking up of the series of Amentaceæ and the interpolation at various places of the miscellaneous families designated by Eichler as Hysterophyta. That the Amentaceæ of Eichler do not represent one circle of relationship has become apparent after close investigation of the ovules and the processes of fertilization. That the establishment of the Hysterophyta was only provisional is evident from their long-known variability as to the gynæceum.

The Ceratophyllaceæ are taken out of Eichler's Urticinæ and placed near the Nymphæaceæ; the Piperaceæ are separated from the Polygoninæ; the Droseraceæ, Sarraceniaceæ and Nepenthaceæ are separated from the Cistiflorae or Parietales as Sarraceniales; the Passiflorinæ are brought under the series Parietales; the series Terebinthinæ and Tricoccæ have been entirely broken up and their separate families referred partly to the Geraniales, partly to the Sapindales or to the Æsculinæ, the

limitation of these latter two series being governed by the orientation of the ovules, a scheme used also by Bentham and Hooker ; the series Frangulinæ or Rhamnales has been restricted to the families Rhamnaceæ and Vitaceæ, while the Aquifoliaceæ, Celastraceæ and Hippocrateaceæ are put in Sapindales. I follow Pax and Baillon in placing the Pittosporaceæ near the Saxifragaceæ. I have united the series Saxifraginæ, Rosifloræ, and Leguminosæ into one series, *i. e.*, the Rosales, since the natural affinity of these groups is beyond all doubt. The Proteaceæ have been excluded from the Thymelæales and placed more toward the beginning of the system near the Santalales, the remaining families being added to the Myrtifloræ or Myrtales.

Of the Sympetalæ the two series Tubifloræ and Labiatifloræ are united ; the Aggregatæ on the other hand are broken up, and the Valerianaceæ together with the Dipsacaceæ placed in the Rubiales, and the Compositæ in the Campanulatæ.

Both subclasses of dicotyledons, Archichlamydeæ and Sympetalæ, are retained, although sharp distinctions between them do not exist. The guiding characters for the disposition of the series under the Archichlamydeæ are chiefly the development of the perianth, the floral axis, and the arrangement of floral parts, but consideration has been given also to the make-up of the ovules in so far as the Casuarinaceæ are concerned, distinguished by numerous megaspores, and for which alone the series Verticillatæ has been made, and is placed at the beginning of the Archichlamydeæ.

Of the remaining series, those which have no perianth must take the lowest place, namely, first the Piperales, then the Salicales, then the Myricales, in which several bracts near the flowers often take the place of a perianth. The Myricales contain only the Myricaceæ, which with the Juglandaceæ I had placed formerly under the Juglandales.

The Balanopsidales with the family Balanopsidaceæ represent an isolated series which occupies a very low place by reason of the rudimentary perianth of the staminate flowers, and the bracteate envelope of the pistillate ones.

The series of Leitneriales with the Leitneriaceæ is doubtful, since we may have to do here with a reduced type. If such were once shown, then this family would come next to the Hamamelidaceæ, near the Rosales.

The Juglandales occupy a higher position, nearly always possessing a perianth, which in the pistillate flowers is coalescent with the carpels, giving rise to apparent epigyny. The Juglandales are further distinguished from the Myricales by chalazogamy, but whether this character is constant must yet be determined.

The Fagales show the same stage of progress as the Juglandales. Coordinate with the Fagales are the Urticales in which the Ulmaceæ precede the Moraceæ and Urticaceæ because of the occurrence of hermaphrodite flowers.

In the Proteales the perianth is sometimes green, but in the majority of cases it is petaloid, but a differentiation of calyx does not appear. This series is easily distinguished from the Santalales by its single free carpel with ventral placentation.

The Santalales, comprising the Loranthaceæ, Myzodendraceæ, Santalaceæ, Grubbiaceæ, Opiliaceæ and Balanophoraceæ, have their gynæceum made up of three (more rarely one or two) carpels, and for each carpel but one embryo sac is developed.

In the Aristolochiales the petaloid segments of the perianth become more or less coalescent, and the carpels are provided with an indefinite number of ovules and an inferior ovary.

The Polygonales form, in certain respects, the transition stage to the Centrospermæ, though the latter is characterized by the presence of perisperm.

Although it is mentioned above that certain series are morphologically further advanced than others, and that on the other hand certain series as the Fagales and Urticales occupy the same morphological stage of advancement, yet each of these series is to be regarded as an independent plant-group, which can in no sense be derived from any of the others. Nor is there any reason to suppose that any of these series constitute a point of divergence for the following series.

In the Centrospermæ heterochlamydy occurs frequently, though it does not yet dominate. The Chenopodiaceæ and Amaranthaceæ form one branch of the series, while the Nyctaginaceæ, Cynocrambaceæ, Batidaceæ, and Aizoaceæ together with the Phytolaccaceæ, in certain respects the center of development, form another branch. Of these the Nyctaginaceæ have reached a higher stage than the Chenopodiaceæ and Amaranthaceæ in that the simple corolla is made of petaloid coalescent segments. The Cynocrambaceæ and Batidaceæ form isolated types which, in common with Phytolaccaceæ, still retain one-ovuled carpels. The Phytolaccaceæ, having free or slightly united carpels, would occupy a low position, save for the appearance of heterochlamydy and cyclic flowers. Still a third subseries is formed by the Basellaceæ and Portulaccaceæ; a fourth by the Caryophyllaceæ.

Of the numerous heterochlamydeous series the first is Ranales, characterized by predominating apocarpy and hypogyny. It has preserved a strong tendency to the spiral arrangement of floral parts, but heterochlamydy is much more frequent than in the Centrospermæ, and zygomorphism occasionally occurs. At least four subseries are to be distinguished. The Nymphæaceæ and Ceratophyllaceæ form the first; the rather isolated Trochodendraceæ the second; the Ranunculaceæ, Lardizabalaceæ, Berberidaceæ, and Menispermaceæ, the third. This third subseries has a probable common origin very near the Nymphæaceæ. The fourth comprises the Magnoliaceæ, Lactoridaceæ, Anonaceæ, Myristicaceæ, Gomortegaceæ, Monimiaceæ, Lauraceæ, and Hernandiaceæ, all characterized by the presence of oil cells. I have named these subseries respectively the Nymphacineæ, Trochodendrineæ, Ranunculineæ, and Magnoliineæ. In the three larger, which are further advanced than Trochodendrineæ, there occurs the change from spiral to cyclical flowers.

Since in the Ranales the spiral arrangement, indefinite numbers of parts in androœceum and gynæceum, and apocarpy all appear as dominating characters, it is clear that the other series

diverge from the Ranales in various ways, some following one direction of development, some another.

The Rhœadales have long been recognized to be closely related to the Ranales, for the Papaveraceæ show analogies with the Nymphæaceæ in their mostly numerous stamens, and in the occasional occurrence of several (though united) carpels in the gynæceum.

The Sarraceniales furnish a parallel series to the Rhœadales. This series shows much in common in the arrangement of floral parts with the Nymphæaceæ and Papaveraceæ. The placentation in the Sarraceniaceæ is the principal character distinguishing the series from the Rhœadales.

I have considerably extended the Rosales, which very often have apocarpy and hypogyny or perigyny in common with the Ranales, but more often show syncarpy and epigyny. The series comprises the Saxifragineæ, the Rosifloræ, and the Leguminosæ of Eichler. We have never been able to discover a comprehensive distinction between the Rosaceæ and Saxifragaceæ; nor is there any dividing line between the Rosaceæ and the Leguminosæ sufficient to warrant putting them in separate series. It may seem strange that the Podostemonaceæ stand at the beginning of Rosales, but Warming has shown their connection with the Saxifragaceæ on the basis of floral structure. The Leguminosæ and the Connaraceæ are to be regarded sister-families of the Rosaceæ, since the families of Rosales are, as a whole, so nearly related that it is difficult to conceive of them under subsections. The Saxifragineæ, however, form a center of development, from which the Podostemonineæ branch in one direction, the Rosineæ in another.

In both the Geraniales and the Sapindales the cyclic arrangement of floral parts is complete, but the still imperfect union of the carpels is a ground for placing both series before the Malvales and Parietales. The two series may only be distinguished by the ovule characters. In the Geraniales the Geraniaceæ and the Oxalidaceæ are followed by the zygomorphous and oligomerous Tropæolaceæ. I have then followed with the Zygophyl-

laceæ, which occupy mostly the same plane as the Geraniaceæ, but in the other direction they approach very near to the Cneoraceæ, Rutaceæ and Simarubaceæ. Since the Rutaceæ are intimately connected with the Simarubaceæ, Burseraceæ and Meliaceæ, it is possible to conceive of these families all together as Geraniineæ. Morphological advance in another direction is seen in the Malpighiineæ. It is expedient also to distinguish the Polygalineæ, Dichapetalineæ and Tricoccæ as subseries, which possess scarcely any surviving common features.

In the Sapindales, considering the entire organization, foliar arrangement and anatomy, we are forced to establish a large number of subseries. At the first are the Buxineæ, provided that the simple perianth is primitive rather than reduced. The Empetraceæ, Coriariaceæ, and Limnanthaceæ occupy similar rank in the character of perianth and the number of ovules, but are withal so distinct that each family must be regarded as the representative of a subseries. The resinous Anacardiaceæ may be regarded as an independent subseries coordinate with and opposed to the Celastrineæ and Icacineæ. Thc Sapindaceæ comprise the closely related Aceraceæ, Hippocastanaceæ and Sapindaceæ, and the Sabiineæ, Melianthineæ and Balsamininеæ. The setting apart of so many subseries shows there is no sufficient ground for the derivation of the more complex families of the series from the simpler.

The Rhamnales are now confined to the tetracyclic Archichlamydeæ with opposite stamens.

As in the Geraniales and Sapindales, there are to be found in the Malvales distinct or slightly united carpels, but in the latter case complete syncarpy prevails. I justify my letting the Malvales follow the Geraniales, Sapindales, and Rhamnales by the close relationship of the Elæocarpaceæ and the Chlænaceæ to the Parietales, within which the floral evolution has already reached very complicated floral types. The Malvales clearly show how a family may reach in certain directions a considerable stage of development, while in others it remains far behind. Conditions are present which show that the near related families

of the series are coordinate and not serial; that they stand side by side, but have not proceeded one from another. The Scytopetalaceæ have a very uncertain position in the series.

As already indicated, the Parietales reach back in their affinities through their simpler families to the region of the Ranales. The Dilleniaceæ were also formerly reckoned with the Ranales, but they show affinities for the tropical families Eucryphiaceæ, Ochnaceæ, Caryocaraceæ, Marcgraviaceæ, Quiinaceæ, Theaceæ, Guttiferæ, and Dipterocarpaceæ, and I have brought them all together as a subseries, Theineæ. Another subseries, the Tamaricineæ, is made up of the Elatinaceæ, Tamaricaceæ, and Frankeniaceæ, which mostly inhabit temperate zones. The Fouquieriaceæ, which in the *Pflanzenfamilien* were reckoned with the Tamaricaceæ, are better separated as an independent family and subseries, on account of their gamopetalous corolla and oily albumen. The changes which have been made in this series are based chiefly upon the results obtained by Dr. Pritzel in his late studies of the seeds of Parietales. His data have great value in the determination of the genetic relationships. Such a series as the Parietales is not to be regarded as a single monophyletic circle of relationship, but as a complex of such circles, which, proceeding from various starting points, have either arrived in their evolution at the same morphological stage of advancement, or, like the subseries Flacourtiineæ, still show various stages of development.

The Opuntiales, with their spiral floral arrangement and tubular receptacle which encloses the syncarpous gynœceum, show quite a primitive floral type, essentially departing very little from that of many Nymphæaceæ. The only reasons for placing this series next the Parietales is that free carpels never occur in the Cactaceæ, that the placentæ are parietal, and the styles are united.

In the series Myrtifloræ and Umbellifloræ the envelopment of the gynæceum within the receptacle has become the rule, and, in contrast to the preceding series, the arrangement of stamens is constantly cyclic. In the Myrtifloræ perigynous and epigy-

nous insertions prevail; in the Umbellifloræ only the epigynous occurs. The series Thymelæales, which formerly, following Eichler, I placed next to the Myrtifloræ, I now believe to be only a subseries of the latter. In those families formerly regarded as Thymelæales perigyny, tetramery, a tendency to apetaly, and a small number of ovules in the carpels prevail, but every one of these characters also occurs in the Myrtifloræ. The Halorrhagidaceæ and the Cynomoriaceæ I regard as representatives of an independent subseries, whose flowers show a most remarkable agreement with Hippuris. That the Umbellifloræ belong at the end of the Archichlamydeæ is certain by reason of their one-ovuled carpels and mostly reduced sepals. The close interrelationship of the three families belonging here is without question.

The opinion has often found expression that the Sympetalæ may be only monopetalous. This cannot be the case, and it is equally certain that the various series of the Sympetalæ are not to be regarded as a continuation of the Archichlamydeæ. When sympetaly arose in prevailingly archichlamydeal series, such sympetalous genera were naturally placed in archichlamydeal families. The subclass Metachlamydeæ or Sympetalæ thus comprises those families in which connate petals have become the rule. Just as the series indicates the stage at which certain genetic subseries have arrived, so the subclass Sympetalæ may be looked upon as a stage for morphologically further advanced series.

The Ericales and Primulales belong at the beginning of the Sympetalæ, for here distinct petals still occur, and two staminal whorls are typical, whereas in the remaining series, with the exception of the Ebenales, only one staminal whorl is developed.

The Ebenales are distinct from the Ericales in that the flowers are not obdiplostemonous, but diplostemonous or triplostemonous, or they may contain numerous stamens. They differ from the Primulales in the septation of the ovary, and from the remaining series in the possession of more than one staminal whorl.

The Contortæ are by no means to be sharply distinguished from the next comprehensive series, Tubifloræ. It is simply a question of differing tendencies of development. One subseries, the Oleineæ, with the families Oleaceæ and Salvadoraceæ, sometimes still possesses distinct petals. In the second subseries, the Gentianineæ, belong the Loganiaceæ, Gentianaceæ, Apocynaceæ, and Asclepiadaceæ, the first of which comprises genera which show characters common also to the three other families, but also contains genera which lean more toward the Tubifloræ and Rubiales. The Loganiceæ may thus represent an older type, from which the other families of Gentianineæ, and perhaps the Rubiales, have branched off.

The largest and most difficult series is the Tubifloræ, within which numerous families are separated from one another only by very poorly defined characters. Advancement takes place from those families with actinomorphous flowers and several-ovuled carpels to those with zygomorphous flowers and few-ovuled carpels. But in a part of the Tubifloræ the tendency to claw-formation especially prevails, and in these the carpels contain only a few, often only two ovules. In close connection with these Tubifloræ are the Hydrophyllaceæ and Convolvulaceæ. Therefore, I distinguish first the subseries Convolvulineæ, with the Convolvulaceæ and the Polemoniaceæ. The Borragininеæ constitute the second subseries, of which the Hydrophyllaceæ possess capsules and may be regarded as the starting point for those Borraginaceæ which possess claw-fruit. The subseries Verbenineæ joins on to the Convolvulaceæ by having in the Verbenaceæ and the Labiatæ the ovule with the micropyle directed downward. Then come the numerous families which group themselves about the Solanaceæ and Scrophulariaceæ in which placentæ with numerous ovules mostly occur. These I have grouped together under the subseries Solanineæ. Between them and the Convolvulineæ are the Nolanaceæ. The Acanthineæ belong near the Solanineæ, yet owing to the great number of peculiarities of the Acanthaceæ, and in spite of certain points in common with the Bignoniaceæ and Scrophulariaceæ, I have ventured to separate them as a subsection.

Some botanists might prefer to put the Plantaginales under the Tubifloræ, but in that case, on account of the upturned micropyle, they would form a special subsection near the Boraginineæ. I have placed them next the Tubifloræ as an independent series.

The epigynous Rubiales and Campanulatæ form naturally the close of the Sympetalæ. In both series we find actinomorphy and capsules with numerous ovules; in both series the further stages of zygomorphy and reduction are reached.

In the series Rubiales, to which, following Fritsch and Hoeck, I have added the Valerianaceæ and Dipsacaceæ, I do not regard division into subseries as necessary. Both the families just named join quite closely to the Caprifoliaceæ. We can only venture to offer a special subseries for the peculiar Adoxaceæ.

In the Campanulatæ, on the contrary, the Cucurbitaceæ occupy a special place, and form the subseries Cucurbitineæ. The Campanulaceæ must be regarded as the remnant of a trunk from which the others have branched out. That the Compositæ occupy the last place in the system can scarcely any longer be doubted.

It is evident that the several series are independent formgroups which have developed mostly side by side, but not from one another. In only a few cases do the series stand so near together that a common origin must be supposed. The same is true also of the subseries and of the families within the subseries. Even within the families themselves it is mostly not possible to determine a common starting point for the subfamilies. In spite of all the uncertainty that prevails regarding the origin of series, it is absolutely certain that parallel development has very often taken place, and the view that in the development of the siphonogams from the asiphonogams a great number of parallel series came into existence from the beginning seems tenable. The oldest monocotyledons and dicotyledons, like the living conifers and other gymnosperms, possessed no floral envelope, but an indefinite number of stamens and carpels, which were either spiral or whorled within the

same tribe. Then from the bracts preceding these sexual phyllomes, or from the lowest stamens, the perianth was developed. In a few scattered tribes of monocotyledons and dicotyledons these lower stages are still to be found, but in others, where cyclical arrangement and definite numbers prevail, they have disappeared. We cannot know whether or not the latter possessed spiral arrangement of members originally; indeed, it is not necessary that this should have been the case, for it is possible that at the very first formation of series, forms with spiral and also with cyclical arrangement should have arisen. Thus fixation of number could have appeared early in the one and late in the other.

Nägeli believed that every tribe has proceeded from early types with spirally arranged floral phyllomes. If this were true, then the Orchidaceæ, for instance, would be the oldest of monocotyledon types, and the Umbelliferæ and Compositæ very old types of dicotyledons, for they would have gone through the most modifications. However, in my opinion, there is nothing against the view that cyclical arrangement arose in certain tribes from the very beginning. In the most of these tribes and series fixation of number probably appeared very early, and of these many afterward suffered modifications by reduction of particular members or multiplication of others. In those series in which wind-pollination prevailed, Pandanales, Glumifloræ, Principes, Fagales, a highly developed corolla, having no particular value, stood no chance of transmission to the generations following. Modifications could only take place in other directions, particularly in the reduction of the number of members, which in certain Glumifloræ, Piperaceæ, Salicaceæ, Urticaceæ, and Chenopodiaceæ has reached its extreme limit. Or modifications may also occur in the form of complex inflorescence. But where the perianth is petaloid and insect-pollination has become established, finally zygomorphy follows, and thereby reduction, which attains considerable importance in such families as the Pontederiaceæ, Leguminosæ, Philydraceæ, Rutaceæ, etc. Although in the reduction of petaloid and hetero-

chlamydeal flowers I have ascribed much influence to insect-pollination, yet I must contend against the opinion that the formation of petaloid structures has been induced by insect-pollination. The appearance of these structures in various and widely separate series can at first only have been conditioned upon external influences. In countless culture plants we see that by supplying richer nutrient materials and more light the formation of petaloid structures notably increases, and that sepals and stamens become petaloid. But it is to be conceded that insect visits may contribute to the fixation of such characters when once acquired, but they alone could not accomplish this were the physiological causes of color supply not permanently furnished to the succeeding generations. The development of color material in the floral phyllomes may also be retarded by its transference to the subtending bracts or to other more favored flowers in the inflorescence. In the Spathifloræ the development of the flowers remains in the background, owing to the manifold capabilities of the spathe, while the petaloid bracts of Dalechampia in the Euphorbiaceæ produce the same result. The inner flowers in the inflorescence of Hydrangea are retarded by the strong petaloid development on the periphery. On the other hand, insect-pollination is decidedly instrumental in the reduction of flowers, more than in the special petaloid development of particular perianth-whorls. For it is quite clear that when the insects continually prefer in their visits those stamens or carpels most conveniently situated, those not used must gradually become functionless. Here it is not a question of production of certain materials, as in the case of the petaloid perianth, but only of restriction or suppression of already existing structures at the expense of other more vigorous ones.

Among the monocotyledons the Scitamineæ and Microspermæ surpass all others in the production of petaloid floral parts, in the prevalence of zygomorphy, and in the reduction of the andrœceum. In the dicotyledons these conditions appear in a great number of series.

BERLIN.